

Measuring SI Performance

Systematic Internalisers (SIs) are a significant source of liquidity in today's MiFID II world, but there is a lot to understand before investors can maximize the benefits and transparency provided by SIs. In this article, we provide insight into how, when and why Virtu's algorithms incorporate liquidity from SIs and how we measure performance.

WHAT SI VENUES DO VIRTU ALGOS USE?

Our algorithms currently have access to the Systematic Internalisers operated by five firms: Virtu Financial (VFSI), Citadel Securities (CCEU/EUCC), Hudson River Trading (HRSI/HREU), Jane Street Financial (JSSI) and Tower Research (TRSI/TOWR). Our objective is to provide our algorithms with additional sources of unique liquidity as is appropriate.

When we consider onboarding or routing to an SI counterparty, we evaluate the unique benefits the SI brings over and above what we already have access to. Rather than take multiple streams from every SI, we typically optimize around a single stream from each, ensuring our counterparties get a representative and meaningful amount of flow. This approach incentivizes our SI counterparties to continually improve their liquidity and performance, while also reducing potential market impact to our parent orders. Additionally, we offer our SI counterparties the option to allow us to "sweep" their liquidity (i.e. take what they are offering and then trade immediately in the lit markets if we don't fully fill).

Below is a summary of the different characteristics of the SI venues we use:

SI	Main Feature	2019 Flow ¹	Below SMS	Above SMS	Allow Sweep	Price Improve	Market Data
A	Large Size	9.04%	✗	✓	✓	✗	✗ ²
B	High Presence	16.37%	✓	✓	✓	✗	✓
C	Price Improvement	19.45%	✗	✓	✓	✓	✓
D	Large Size	31.22%	✓	✓	✓	✗	✓
E	Price & Size	23.91%	✓	✓	✗	✓	✓

¹ Since most recently added SI has been live (15th Feb 2019)

² SIs not providing quotes are restricted to only interacting with vanilla SOR flow, not algo orders



HOW DO VIRTU ALGOS PRIORITIZE BETWEEN SI VENUES?

Most traditional algorithm platforms decide when and how much to trade. At Virtu, instead of separating algo and SOR components, each of our algorithms are aware of the full depth of book information across venues and control over which venues the algo route to and when. This is key to the way we build algorithms. Ensuring the algorithm is able to see all of this information gives it the context it needs to make informed decisions.

An algorithm's decision of how and when to use SIs is considered in the same way: on an algorithm-by-algorithm basis, and on a per-action or per-intention basis within those algorithms. This allows us to look for opportunities where we would be willing to cross the spread to trade with an SI but not on a lit market, based on the characteristics of the lit order book. That is not to say; however, that our algorithms will always route to an SI each time they decide to cross the spread. Our algorithms decide when it is appropriate (e.g. a catchup child order on a VWAP order) and when it is not (e.g. reacting to a latency sensitive lit signal that the far side of the book may be trading away). Of course, there will also be times an algo may decide it wants to trade exclusively with SIs (e.g. an SI quote feed uniquely offers a mid-point price).

When an algorithm does decide to trade on an SI, we employ a real-time SI ranking process to select which SI quotes to engage. The ranking considers several factors, with each factor generating a score on a sliding scale from 0 to N that is equally weighted in terms of its impact on the overall ranking. This ranking algorithm may use real-time markouts generated on trades from the same trading session.

Description		Dynamic Scoring Mechanism
Price Improvement	Amount of price improvement offered relative to EBBO	0 for matching the EBBO, score increases with % of the spread offered
Size	Amount of size being offered right now relative to our child and EBBO	0 for no size, score increases with size relative to the child order size 0 for no size, score increases with size relative to the EBBO
Concentration	How "concentrated" is our activity with counterparty	Max score if we haven't traded this symbol with this SI today. Trends to 0 the more we trade with the same SI
Tie Breaker	Static weight for if the other scores are equal as a tie breaker	Score derived from performance metrics on markouts, hit rates, etc

This dynamic ranking algorithm ensures a fair allocation of flow across SI counterparties. It is important to note that price is not the main factor, even though it typically is for lit markets; sometimes we are willing to forgo price improvement on the child order if the size or potential information leakage implications suggest it is better for the parent order. Our intention is to maximise the performance of the parent order, not just capture small price improvements at the child level when it may not be in the best interest of the parent. This allows us to encourage our SIs to provide large size and price improvement over the long term.



HOW DOES VIRTU MEASURE SI PERFORMANCE?

Many industry experts measure venue performance (including SIs) by focusing solely on markouts (i.e. what happens to the EBBO at certain intervals post trade). While this is certainly a useful tool, Virtu believes that important context is lost by reducing a venue's performance to a single metric. We take a more holistic approach by analyzing several key performance indicators in addition to markouts, including:

- Price improvement (amount and frequency)
- Trade sizes (average and largest)
- IOC success rates (hit and fill)

We also believe it is important to drill down within each of these statistics to fully recognize the situations under which an SI performs well, instead of looking at the overall blended performance for each metric. Our nuanced approach allows us to further refine our algorithms' interactions with each SI and to engage with SIs on how to improve performance in various scenarios. In the analysis below, we look at 635 thousand trades in over 1,600 securities that our algorithms executed on SIs in Q1 2019, with the comparable lit MTF data restricted to the same symbol universe. The charts titled "Markouts" can be found on the following page.

Markouts are an excellent place to highlight the importance of this analytical framework. On the left-hand side of the markouts charts (Point 1), we see the overall performance for each venue in terms of how the EBBO midpoint moves at various time points after a trade. As you can see, on average, trading with an SI looks "better" than trading on lit MTFs. Indeed, the blue and green venues (SI D and E) look particularly good with minimal change in the midpoint up to 1 minute after a trade.

Let's break down the scenarios and how these lines are formed. Two particularly suitable permutations to consider relate to the characteristics of the streams we receive from each SI: whether they provide above and/or below SMS quotes ("By Size" in the charts), and whether they allow us to sweep their quotes ("By Sweep" in the charts).

You can see that the markouts for all venues for Below SMS are better than Above SMS (Point 2), which is expected given the smaller trade sizes. You can also see that sweeping generally is accompanied by worse markouts (Point 3), which again is logical if the SI can't fully satisfy demand; the algo will trade in the lit market and likely influence the reference price on which the markouts are based.

Looking at the green line (SI E), which does not allow sweeping – as evidenced by the lack of a green line on the Sweep charts – we see that SI E's overall performance is skewed to the situations that it finds most favorable. Can it therefore be looked at as the "best" on an aggregate markout performance basis (Point 4)?

The last four SI Markouts charts ("By Size/Sweep") illustrate the permutations of these two sets of criteria and show what we expect: large, sweeping orders have the worst markouts. We also note that some SIs have worse performance than the lit markets over a longer duration (Point 5).

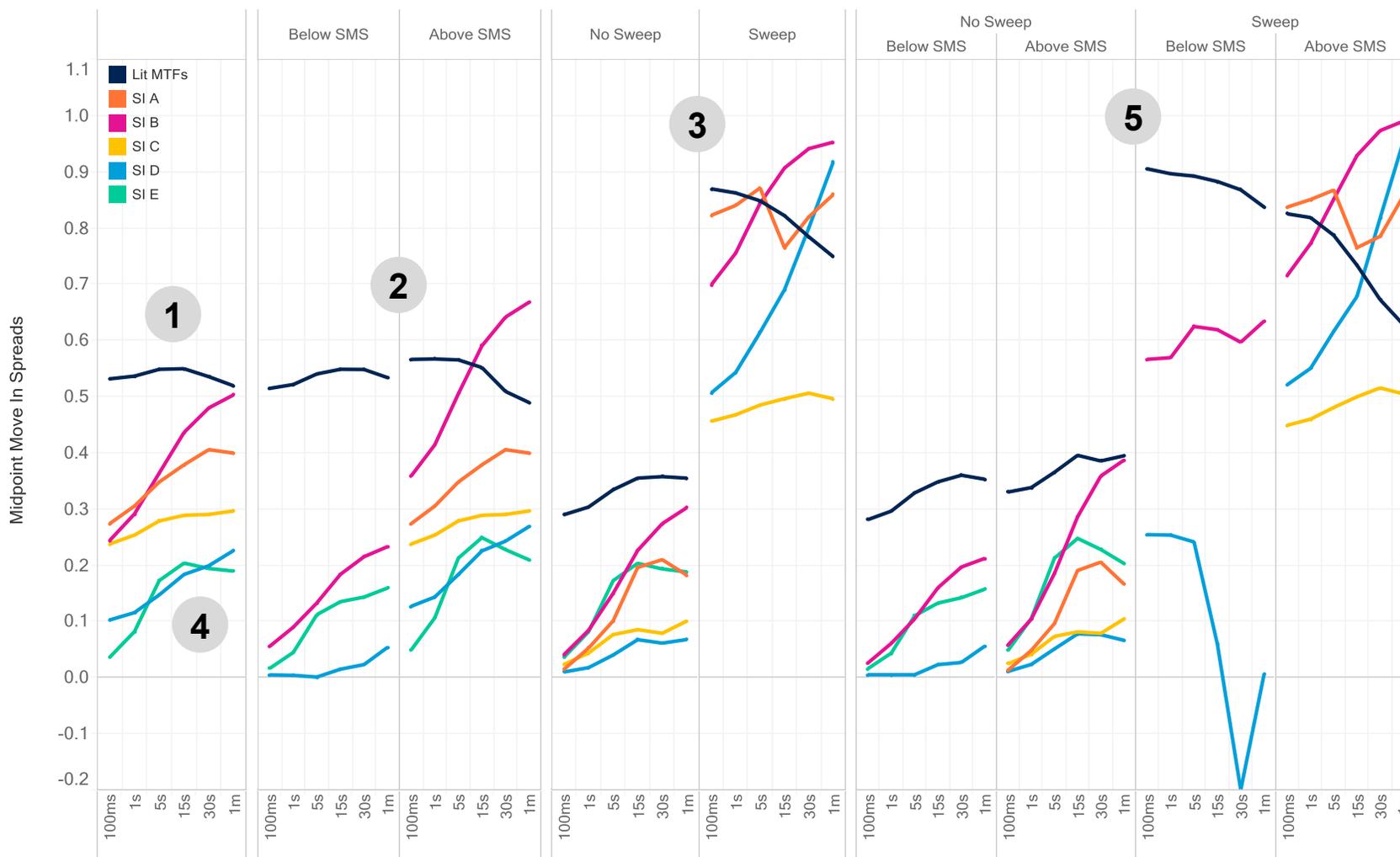


SI Markouts - Overall

SI Markouts - By Size

SI Markouts - By Sweep

SI Markouts - By Size/Sweep



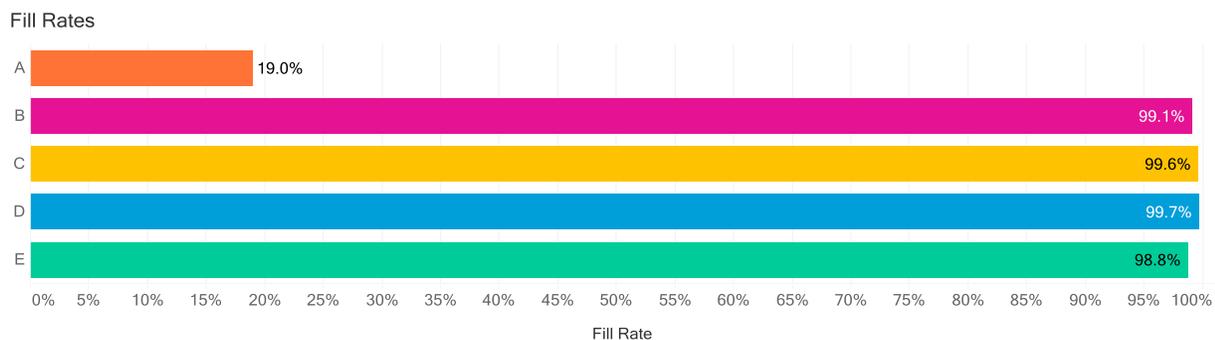
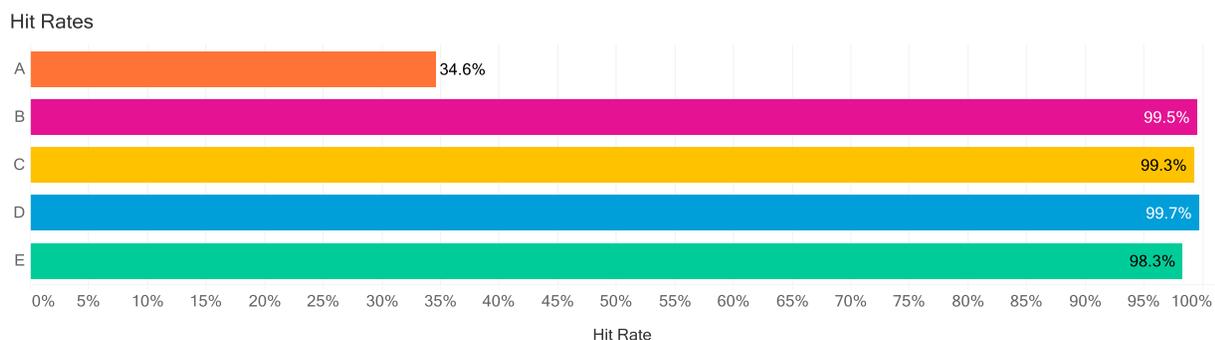
Source: Virtu



The statistics in the next set of charts (titled “Statistics” on the next page) highlight the distinguishing characteristics of each SI, which we again break down into the same sweep and size categories. As we saw from the markouts, the performance for above SMS sweeping flow is relatively poor; however, nothing in the markouts indicates the frequency of occurrence or the relative size of the trades. For example, if the SI provided us on average 5x the EBBO size in those situations then it may be relatively good performance considering how much the equivalent move of the lit markets it may have taken to trade the same size.

SIs C and E provide price improvement consistently (Point A), while SI C provides slightly less size and certainty of price improvement compared to SI E, which offers less price improvement overall but provides some on almost every trade (Point B). SIs A and D are meeting their objective of providing significant size (Point C), while SI D stands out on both average and max trade size metrics in most size and sweep categories (Point D).

From a hit and fill rate point of view, all SIs are good at honouring their quotes; we achieve >98% success rate. Even SI A, that currently is not streaming us quotes, has an impressive 35% hit rate on child orders from our vanilla SOR strategy.



Source: Virtu. Note hit rate is measured as whether any shares were executed or not (0 for no shares, 100 for 1 share or more)

From these simple sub categories of performance, it's clear that breaking down the scenarios under which an SI (or any venue) performs well is important, and this analysis is just a sample of the myriad ways to analyze performance – including by country, market cap, time of day, etc.



Statistics - Overall

Statistics - By Size

Statistics - By Sweep

Statistics - By Size/Sweep



Source: Virtu. For reference lit MTFs avg trade size is \$4,900 (or \$17,750 for above SMS), with a max size of \$770k. No price improvement versus the EBBO



WHAT YOU DON'T SEE: ANALYZING SI QUOTE STREAMS

All the performance metrics above are based on executed trades, which do not illustrate the entire opportunity. Looking at SI quote streams gives us insight into situations where SIs were willing to trade but we were not. This information shows the opportunity presented to the algorithm and can be useful to improving performance. This analysis can be useful to identifying the uniqueness of each SI.

Let's start with a sample book snapshot from RDSA NA at the start of March 2019:

SI C and E are offering price improvement on both sides of the book (10% and 3% respectively). SI C quote size is imbalanced whereas SI E is not

The EBBO has 12270 shares on the bid and 16538 shares on the ask

RDSA NA at 10:50:39.493627 on xx xx 2019						
SI C	3255	27.446	27.454	3042	SI C	
SI E	5100	27.4453	27.4547	5100	SI E	
SI B	3276	27.445	27.455	4334	SI B	
SI D	12445	27.445	27.455	12445	SI D	
XAMS	6386	27.445	27.455	8635	XAMS	
CHIX	2268	27.445	27.455	2824	CHIX	
TRQX	1383	27.445	27.455	1316	TRQX	
BATE	1329	27.445	27.455	1722	BATE	
AQXE	904	27.445	27.455	2041	AQXE	
XAMS	8147	27.440	27.460	12610	XAMS	
CHIX	3720	27.440	27.460	2678	CHIX	
TRQX	1241	27.440	27.460	1311	TRQX	
BATE	2599	27.440	27.460	1619	BATE	
AQXE	528	27.440	27.460	1548	AQXE	

SI B imbalanced in its size, providing more on the ask than the bid

SI D offers a very large size relative to the other SI's and the EBBO itself (indeed is larger than the lit bid qty). Note same quoted size on both sides.

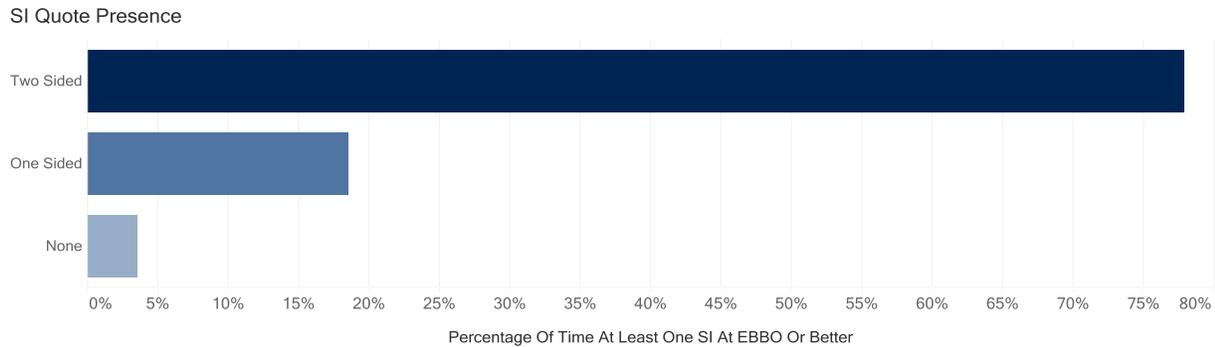
SI's have 24,076 shares on the bid and 24,921 shares on the ask, which represents a **3x** and **2.5x** increase in shares available at the EBBO versus what is visible on lit venues

How common is this scenario? Is it usual that all four SIs are competing at the same time? Are SI quotes usually two-sided? Are the sizes representative of typical sizes?

To answer these questions we analysed SI quotes received from 15th February 2019 to 15th March 2019 in SX5P constituents, excluding Spanish and Swiss instruments to ensure that the symbol set was quoted by all SIs.



The first set of statistics below addresses the question of how often we see two-sided and/or overlapping quotes between SIs. This chart tells us that for 96.5% of any given day in our sample set, at least one SI provided a one or two-sided quote at or better than the EBBO.



Source: Virtu

Situations like the RDSA NA example, however – where at least one side of the book has all four SIs at or better than the EBBO – happen just 14.9% of the time when an SI is present. The most likely scenario has SI quotes on both sides of the book, with two SIs competing on each side.

Permutations Of Overlapping SI Quote Presence At EBBO Or Better



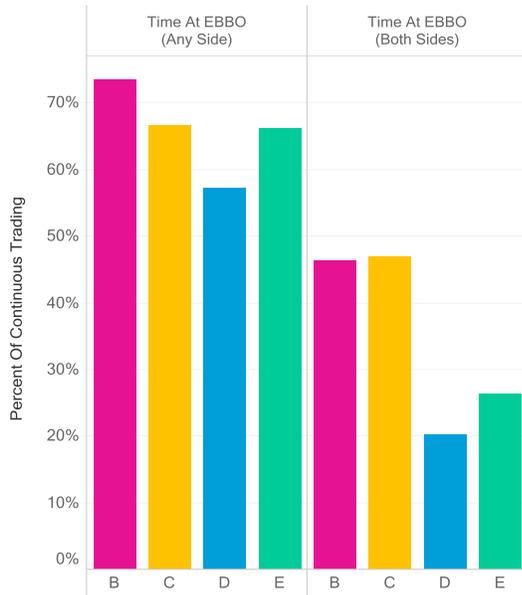
Source: Virtu

Whilst all four SIs that stream to us have a quote at or better than the EBBO 60-70% of the time, it is interesting to observe the frequency with which each SI has one-sided or two-sided quotes: Two of the SIs are more frequently quoting on both sides simultaneously, while the others typically quote single-sided, perhaps to offset positions.

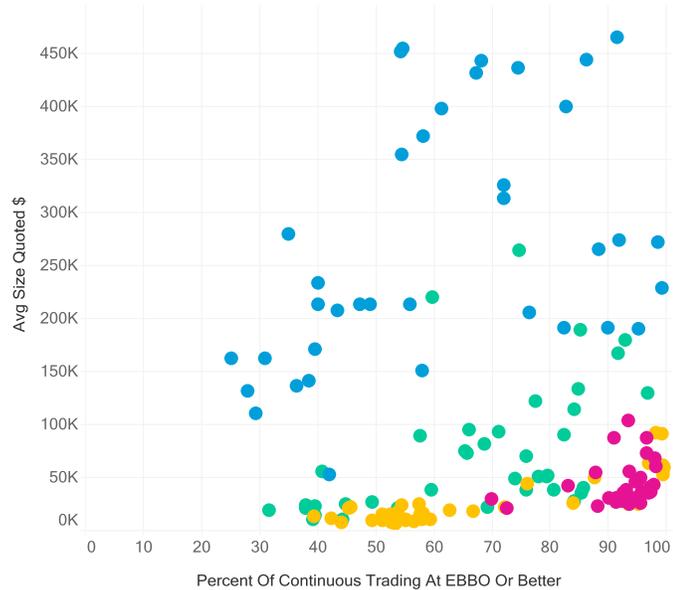


It is also interesting to note that quoted size seems to be positively correlated with quote presence at or better than the EBBO for SIs that quote single-sided more often than two-sided; that is, larger sizes accompany increased availability of displayed liquidity at the EBBO.

Per SI Presence At EBBO Or Better



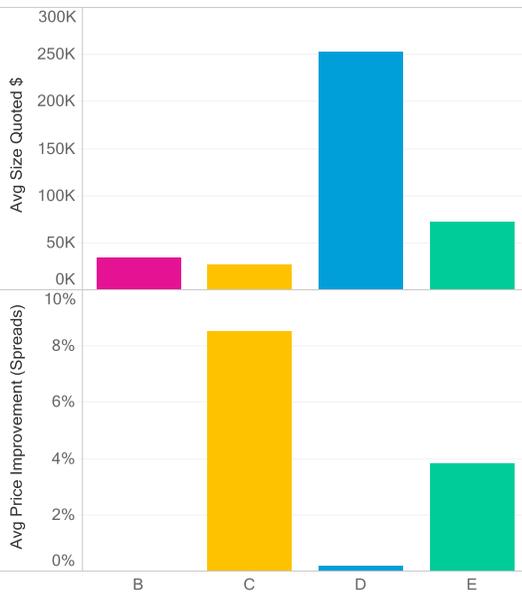
Quoted Size Vs EBBO Presence



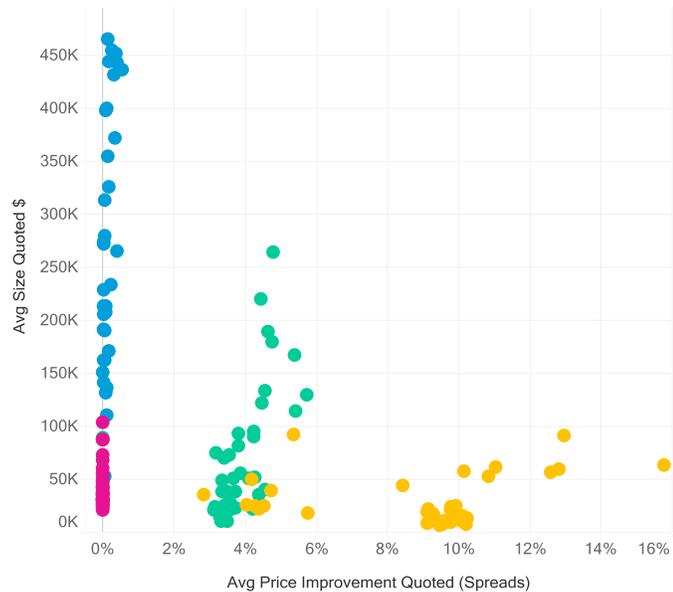
Source: Virtu

Finally, we compared our fills to the average quoted sizes and price improvement offered on each SI. In general, we capture available price improvement and size improvement, given limitations of the parent/child order sizes.

Per SI Presence At EBBO Or Better



Quoted Size Vs Price Improvement



Source: Virtu



OTHER CONSIDERATIONS

ESMA announced recently that SIs will be subject to the tick size regime which will remove the availability of price improvement in most circumstances. With the majority of spreads 1 or 2 ticks wide, current levels of price improvement at 5-10% will not itself be on-tick; therefore, the quotes will likely be rounded back. For more information see:

<https://data.consilium.europa.eu/doc/document/ST-7460-2019-ADD-2/en/pdf>

Article 17a - Systematic internalisers' quotes, price improvements on those quotes and execution prices shall comply with tick sizes set in accordance with Article 49 of Directive 2014/65/EU. Application of tick sizes shall not prevent systematic internalisers matching orders large in scale at mid-point within the current bid and offer prices

A final thought: As discussed throughout this paper, SI streams tend to be tailored to each broker and how that broker engages with an SI's liquidity. Therefore, Virtu's experience with these SIs is likely to be different from that of other brokers, not solely because of our algorithms' logic but also due to any tailoring the SI has done based on the characteristics of the flow it receives from Virtu. Accessing an SI is a transparent bilateral relationship with the onus on both sides to ensure trading is beneficial for the end client and sustainable for the liquidity provider. How well this relationship is managed ultimately impacts the end client's performance.

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